Only the following animals have corpuscles larger than man, i.e., larger than $\frac{1}{3200}$ of an inch; viz., the elephant, great ant-eater, walrus, sloth, platypus, whale, capibara, and (according to Wormley) opossum. Animals the corpuscles of which are slightly below man in size, i.e., having corpuscles from $\frac{1}{3500}$ to $\frac{1}{3200}$ of an inch average diameter, are the seal, beaver, musk-rat, porcupine, monkey, kangaroo, wolf, and guinea-pig. None of these are domestic animals. All other animals, including all domestic animals, have blood-corpuscles of a mean diameter less than $\frac{1}{3500}$ of an inch; and, in fact, those animals which, as a rule, are blamed for blood-stains found on the clothing and apparel of criminals (ox, pig, horse, sheep, and goat), have corpuscles with an average diameter less than $\frac{1}{4000}$ of an inch. He summarizes the facts as follows: —

1. The blood-corpuscles of birds, fishes, and reptiles, being oval and nucleated, can never be mistaken for human blood.

2. Fresh human blood cannot be mistaken, under the microscope, for the blood of any animal the corpuscles of which have a mean diameter of less than $\frac{1}{4000}$, or even $\frac{1}{3600}$, of an inch.

3. (*a*) If the average diameter of blood-corpuscles in fresh blood is less than $\frac{1}{4000}$, then it cannot possibly be human blood; (*b*) if the diameter is more than $\frac{1}{3500}$, then it may be human blood; (*c*) if the blood-corpuscles, after exhaustive measurement, give a mean diameter of more than $\frac{1}{3300}$, then it *is* human blood (provided it is not the blood of one of the wild beasts referred to).

The foregoing applies especially to the diagnosis of fresh blood. With regard to dried blood, it is claimed that this can be recognized just as readily, provided it has dried quickly. Blood that has dried slowly undergoes decomposition, and its morphology cannot be made out. A good liquid for remoistening blood is Müller's fluid; but perhaps the best is Virchow's solution, composed of thirty parts caustic potash and seventy parts water. At least five hundred measurements should be made in order to establish the average diameter of the cells.

If the corpuscles are spheroidal from absorption of moisture, or crenated from drying, they may still be diagnosed, because such changes are the same in the corpuscles of all animals, and have really their proportionate and corresponding ratio of alteration in form and diminution in size, the range or scale of diminution being always alike in the same animal.

The red blood-corpuscles that have become spherical from imbibition of liquid have thus presented in Dr. Formad's experiments the following average diameters in the various animals: 1. Man, $\frac{1}{4300}$ inch; 2. guinea-pig, $\frac{1}{4500}$ inch; 3. Wolf, $\frac{1}{4600}$ inch; 4. Dog, $\frac{1}{4800}$ inch; 5. Rabbit, $\frac{1}{4900}$ inch; 6. Ox, $\frac{1}{5600}$ inch; 7. Sheep, $\frac{1}{6700}$ inch; 8. Goat, $\frac{1}{8100}$ inch.

These figures show that the diameter of the artificially spherical corpuscles in each animal is just about one-third less than that of the normal bi-concave or disk-like corpuscles of the same animals.

The question has long been a mooted one, as to whether the microscope can be depended on to determine positively, or not, that a given specimen of blood is that of a human being. Dr. Formad believes that this can be done, while other microscopists of equal eminence deny the possibility.

VACCINATION. — That small-pox has greatly declined in England during the past fifty years is apparent from figures which have been published by Dr. Henry Thorne. From 1838 to 1842 the deaths from small-pox in England amounted to 57.2 per 100,000; in 1880–84 the death-rate was 6.5 per 100,000. He thinks that vaccination has not only a direct influence in causing this reduction in the number of victims to small-pox, but that it has also a tendency to decrease the liability to the disease of children of vaccinated parents. In this connection it is interesting to note that *The Medical Press* states, that, out of the five thousand children born every month in Paris, only a thousand are vaccinated by the medical officers appointed for that purpose. The remaining four thousand infants are therefore either vaccinated by private practitioners, or not at all. Seeing, however, that more than half the population apply for and receive gratuitous medical attendance, and that half the burials are gratuitous, it is very unlikely that all of the four thousand are vaccinated at the cost of the parents. It may fairly be assumed that a large proportion are not vaccinated at all, and that is why small-pox exists as an endemic disease at Paris, and does not disappear, as it has done, to a great extent, in Germany.

ELECTRICAL SCIENCE.

Experiments in Proof of the Electro-magnetic Theory of Light.

IN his presidential address before the mathematical and physical section of the British Association, Prof. G. F. Fitzgerald dwelt at length on the recent experiments of Hertz in Germany on the propagation of electro-magnetic disturbances. These experiments are of so much importance, and go so far toward confirming the electro-magnetic theory of light, that a brief *résumé* of the subject will not be untimely.

There have been for years two theories with respect to the action upon each other of quantities of electricity, and of elements of electric current. One held that the various phenomena were caused by direct action at a distance; the other, that they were due to the action of the intervening medium. With respect to the electrostatic phenomena, Faraday's discovery that the capacity of a condenser varied with different dielectrics between the conducting coatings, made the theory of direct action extremely improbable; and his work, with that of Maxwell, has put the theory of an action of the dielectric on a firm foundation.

With respect to electro-magnetic phenomena, however, the case is different. Maxwell, in his magnificent work on electricity and magnetism, developed the idea that electro-magnetic actions are dependent on the surrounding medium, and one of the results is the electro-magnetic theory of light. But there has been no direct and unquestioned proof that there really is such an action in the dielectric as Maxwell has supposed. To illustrate the fundamental ideas involved, suppose we have a condenser made of two sheets of tinfoil with glass between; and suppose, further, that we have a battery whose poles may be connected to the coatings of the condenser. If we suddenly connect the poles to the coatings, there will be a momentary current, which will last only long enough to charge the condenser, probably for only a small fraction of a second. Now, the general idea was, that there was a current in the battery, and in the wires used to connect it with the condenser; and the result was to charge the two coatings, one with plus, the other with minus, electricity; and there the action stopped. Maxwell's idea was, that the current, so long as it lasted, was perfectly continuous, but that in the glass plate the action consisted of a 'displacement' of electricity; that is, considering a number of planes drawn through the conductors and through the glass, perpendicular to the direction of current, the amount of electricity crossing any plane was the same at the same instant, but that in the glass the result was a state of strain, exactly as if a spring were bent. The amount of 'displacement' depends on the displacing force, — the electro-motive force of the battery. When the proper displacement has taken place, all further action ceases, unless the strain is too great, in which case the dielectric breaks down, and we have the well-known phenomenon of disruptive discharge. The amount of displacement determines the charge of the condenser. When the electro-motive force is removed and the coatings joined, the strain in the dielectric relieves itself, producing the discharge.

If we charge the condenser with an alternating current, we have in the glass continuous displacement currents, first in one direction, then in the other.

From this fundamental idea of looking to the dielectric for the really important part of the phenomena, Maxwell was led to consider the laws by which the vibration of electricity on a small conductor would be propagated in the surrounding medium. He found that the equations governing the propagation were essentially the same as those deduced from the elastic solid theory of light; and he found that the velocity of propagation of such a disturbance was equal to a certain electrical constant which has several times been determined, and which agrees, within the limit of experimental error, with the value of the velocity of light. He also showed a relation between the specific inductive capacity and index of refraction of substances, which has not been completely proved, but which is suggestively close.

Here the matter dropped for a while. The theory has been extended, notably by Rowland and Fitzgerald, to account for other phenomena of light, but no experimental evidence of a conclusive nature has been produced.

It had not been shown, until Hertz's experiments were made, that the vibration of an electric current would set up disturbances in the surrounding medium, — the assumption on which Maxwell's theory was based. Hertz proved this in the following way: conducting circuits have definite time-constants, just as stretched strings have definite periods of vibration; and a disturbance whose period is the same as the time-constant of the circuit will produce a greater effect than any other, just as a piano-string will vibrate if one sings the note to which it corresponds. Hertz produced electric vibrations of a short and definite period, — one hundred millionth of a second, of a wave-length of about two metres, — and studied the effect on a receiving-circuit of the same time-constant. The receiving-circuit had a short air-space in it, and sparks were observed leaping across this space. By placing the vibrator several wave-lengths from a reflector, and moving the receiver between the two, he observed that at certain distances the induced sparks were faint; then, on moving the circuit, they became brighter, then disappeared again, — phenomena exactly resembling Lloyd's bands in optics, due to interference. To quote Professor Fitzgerald, "Henceforth I hope no learner will fail to be impressed with the theory — hypothesis no longer — that electro-magnetic actions are due to a medium pervading all known space, and that it is the same medium as the one by which light is propagated; that non-conductors can, and probably do, as Professor Poynting has taught us, transmit electro-magnetic energy. By means of variable currents, energy is propagated into space with the velocity of light."

The experiments of Hertz have made Maxwell's theory of light more than possibly true, and it seems as though light must be hereafter considered as an electro-magnetic phenomenon.

A NEW SYSTEM OF ELECTRICAL DISTRIBUTION BY STORAGE-BATTERIES. — Mr. Henry Edmunds has brought out a new system of distribution by storage-batteries, that seems to have a good deal of merit. The systems that have been used have objections which Mr. Edmunds obviates. Mr. Crompton's plan for using batteries is to have a number of groups in series on the main line, taking the current for distribution from the ends of each group. The batteries are connected with the charging and discharging circuits at the same time. The obvious disadvantage of this plan is that a high potential cannot be used, since the lamp-circuit is liable to have its potential raised to the maximum of the charging circuit; and, with more than four hundred volts difference of potential at the dynamo terminals, this would be distinctly unsafe. The other system consists in having two sets of cells, one of which is being charged while the other is discharging. Mr. Edmunds's is a modification of the latter plan. If he wishes forty-eight volts in the lamp-circuits, he uses thirty-two cells, divided into four sets of eight cells each. Three sets in series are constantly connected with the lamp-circuit, while the fourth set is being charged. A device is provided by which the various sets are put in rotation in the charging and discharging circuits, remaining two minutes in the former, six in the latter. In changing from one circuit to the other, a resistance is put in place of the battery being charged, so the main circuit is never broken. By putting two sets in parallel for an instant, a break in the lamp-circuit is avoided. This plan has the advantage of allowing high electro-motive forces to be used without necessitating a double outfit of batteries; and the efficiency should be greater than when the cells are charged for a considerable period and then discharged.

BOOK-REVIEWS.

The Aryan Race. By CHARLES MORRIS. Chicago, Griggs. 12°. $1.50.

THE present volume is a concise and pleasantly written review of the results of recent investigations on the home and history of the Aryan race. It is intended to be a popular book; and its object — to make clear to the general reader these interesting questions and their solutions, so far as reached to-day — has been well accomplished. The author is careful to give the evidence favoring the various theories as to the origin of the Aryans; and, although he states as his own view that they probably originated in south-eastern Europe, he does not urge his opinion upon the reader, but allows him to draw his own conclusions from the evidence offered. In an introductory chapter the author discusses the division of mankind into races, and claims that the Caucasians are a branch of the Mongols. He even goes so far as to divide mankind into two races, — the Mongoloid and Negroid. Anthropologists will hardly concur with the author's views expressed in this chapter. He next sets forth very candidly the arguments advanced by various writers as to the early home of the Aryans, and continues to trace their migrations as compared to those of other races. From linguistic evidence he describes their early stage of culture, their ancestral and nature worship, and their political development. When the author, in the chapter on the development of language, turns to consider languages other than Aryan, he is somewhat too sweeping in his statements regarding them, and we find throughout the book that the author's desire to eulogize the Aryan race has led him to underestimate the merits of the rest of mankind. The history of the Aryans is followed in general outlines up to the present time; and the book concludes with a glowing prospect of the future, the author assuming that even the fastnesses of Central Africa will become the home of the conquerors of the world.

On the Study of Words. By R. C. TRENCH. New York, Macmillan. 16°. $1.

THIS is the twentieth edition of Archbishop Trench's charming book, revised by A. L. Mayhew. The editor has not made any change in the arrangement of the book, but he has purged it of all erroneous etymologies, and corrected in the text small matters of detail, according to the recent advances of the science of philology. He has done well in altering as little as possible of the author's work, for it would be hardly possible to increase the attractiveness of Trench's style, and of his method of treating his subject. He has set forth the charms of the study of etymologies in a way that can hardly be improved, and that will make every reader a friend of this science. It will also induce the reader to a thoughtful use of words; to considering their "poetry and morality," to use the author's words. It is hardly necessary to recommend the interesting little volume, for the fact that it was necessary to publish a twentieth edition is sufficient proof of its great merits.

The Essentials of Geography. By G. C. FISHER. Boston, N. E. Publ. Co. 8°.

THIS is one of the old-style geographies, which are of no educational value, and only adapted for rote work. It is the briefest possible compilation of geographical facts, arranged without any geographical or educational method. The statements are extremely meagre, and the author has not been sufficiently critical in selecting them to make his book an 'authority,' as he expresses himself in the preface. The book is accompanied by sketch-maps, by the use of which the author hopes to enliven the teaching of geography; which, however, are also only useful for a teacher who is satisfied with routine work, and with cramming the minds of his pupils with facts.

How the Peasant Owner Lives. By LADY VERNEY. London and New York, Macmillan. 12°. $1.

LADY VERNEY has collected some descriptions of the life of peasant-owners in France, Germany, Italy, and Russia, with the object of defending the large English and more particularly Irish estates. She dwells on the fact that small estates cannot be worked economically, especially where they consist of small detached sections. She shows more particularly the evil results of this system in France. The authoress sees the only remedy against these effects in the consolidation of these small estates in the hands of great land-owners and the abolishment of small farms. Her ideal is that the small farmer should not try to make his living out of the produce of his little patch of land, but that he should become a laborer on a large estate. She deems the attempts to consolidate farms, that have been made on the European continent, unimportant, and also hardly touches the state of the workingman-peasants, who earn money as workers in factories, but at the same time own small patches of land on which they raise some of the necessaries of life. From this point of view, she condemns the efforts to create a peasantry in Ireland, and concludes her book with a touching romance, 'A Yeoman's Home in the Dales Sixty Years since.'